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CHEMISTRY
STANDARD LEVEL
PAPER 2

Thursday 8 May 2008 (afternoon)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

0109

SECTION A

*Answer **all** the questions in the spaces provided.*

1. A 0.265 g sample of a mixture of calcium chloride, $CaCl_2$, and potassium nitrate, KNO_3, is dissolved in 50.0 cm^3 of water. This mixture is titrated with 0.100 mol dm^{-3} silver nitrate, $AgNO_3$, which reacts with the chloride ions present to form insoluble silver chloride, AgCl. The titration required 38.5 cm^3 of silver nitrate.

(a) Write an equation for the reaction between calcium chloride and silver nitrate. *[2]*

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(b) Calculate the amount, in moles, of silver nitrate used in the reaction. *[2]*

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(c) Calculate the amount, in moles, of calcium chloride titrated and the mass of calcium chloride present in the original sample. *[3]*

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(d) Calculate the percentage of calcium chloride in the original sample. *[1]*

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2. (a) In a sample of gallium, the percentage abundance of ^{69}Ga is 60.4 and ^{71}Ga is 39.6. Determine the relative atomic mass of gallium. *[2]*

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(b) State the electron arrangement of the following species. *[2]*

(i) A potassium ion

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(ii) A sulfide ion

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(c) Describe the difference between a continuous spectrum and a line spectrum. *[2]*

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3. (a) The standard enthalpy changes of three combustion reactions at 298 K are given below in kJ mol^{-1}.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -394$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H^{\ominus} = -286$$

$$CH_3COOH(l) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) \qquad \Delta H^{\ominus} = -876$$

Use the data above to calculate the standard enthalpy change for the following reaction.

$$2C(s) + 2H_2(g) + O_2(g) \rightarrow CH_3COOH(l) \qquad \Delta H^{\ominus} = ? \qquad \textit{[4]}$$

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(b) Predict, giving a reason, whether the entropy change ($\Delta S^{\ominus}$) for the formation of $CH_3COOH(l)$ would be positive or negative. *[1]*

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4. (a) Explain the term *buffer solution*. *[2]*

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(b) State whether each of the following will act as a buffer solution and give a reason for your choice.

(i) A 1.0 dm^3 solution prepared from 0.50 mol of $NH_3(aq)$ and 0.25 mol of HCl(aq). *[2]*

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(ii) A 1.0 dm^3 solution prepared from 0.50 mol of $NH_3(aq)$ and 0.25 mol of $H_2SO_4(aq)$. *[1]*

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5. (a) The compound C_3H_6 reacts with bromine. Write an equation and state an observation for this reaction. *[2]*

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(b) The product formed in part (a) exists as optical isomers. Draw the structural formula of the product and identify the chiral carbon atom. *[2]*

(c) Suggest the type of polymerization reaction that C_3H_6 undergoes and draw the structure of a section of the polymer chain formed from three monomer molecules. *[2]*

Type of polymerization . . . . . .

SECTION B

*Answer **one** question. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

6. (a) Draw the Lewis structures of the following molecules. Use the VSEPR theory to predict the shape of each molecule and deduce whether it is polar or non polar.

(i) BF_3 and PCl_3 *[5]*

(ii) SO_2 and CO_2 *[5]*

(b) State and explain the difference in the following.

(i) The reactivity of Na and K with Cl_2. *[2]*

(ii) The ease of oxidation of $Br^-(aq)$ and $I^-(aq)$ with Cl_2. *[2]*

(iii) The conductivity of magnesium as compared to sulfur. *[2]*

(c) The oxides of magnesium, aluminium and phosphorus illustrate the change in nature of elements from metallic to non-metallic. Each of the three oxides is mixed with separate samples of pure water. For each of the oxides, state whether the **resulting solution** is acidic, basic or neutral. Write an equation for each reaction that occurs. *[4]*

7. (a) The following equilibrium is involved in the industrial production of nitric acid from ammonia.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H^{\ominus} = -910 \text{ kJ mol}^{-1}$$

Describe the effect, if any, of each of the following changes on the equilibrium concentration of nitrogen monoxide in a particular equilibrium mixture, giving a reason in each case.

(i) Increasing the pressure, at constant temperature *[2]*

(ii) Increasing the temperature, at constant pressure *[2]*

(iii) Addition of a heterogeneous catalyst, at constant pressure and temperature *[2]*

(b) Deduce the equilibrium constant expression, K_c, including units for the forward reaction in part (a). *[2]*

(c) Identify which of the changes in part (a) will affect the value of K_c and predict whether the value of K_c will increase or decrease. *[2]*

(d) When 2.0 g of calcium carbonate pieces, $CaCO_3$, react with 50 cm^3 of 2.0 mol dm^{-3} hydrochloric acid, HCl (aq), at 25°C, carbon dioxide gas is evolved. Describe the effect of the following changes on the rate of reaction between $CaCO_3$ and HCl and explain your answer in terms of the collision theory.

(i) The same mass of $CaCO_3$ pieces react with 50 cm^3 of 1.0 mol dm^{-3} HCl(aq) at 25°C. *[2]*

(ii) The same mass of $CaCO_3$ pieces react with 100 cm^3 of 2.0 mol dm^{-3} HCl(aq) at 25°C. *[2]*

(iii) The same mass of $CaCO_3$ powder reacts with 50 cm^3 of 2.0 mol dm^{-3} HCl(aq) at 25°C. *[2]*

(iv) The same mass of $CaCO_3$ pieces reacts with 50 cm^3 of 2.0 mol dm^{-3} HCl(aq) at 35°C. *[3]*

(e) State why the addition of a catalyst increases the rate of a reaction. *[1]*

8. (a) Consider the following reactions.

$$Ni(s) + Cu^{2+}(aq) \rightarrow Ni^{2+}(aq) + Cu(s)$$
$$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$$
$$Zn(s) + Ni^{2+}(aq) \rightarrow Zn^{2+}(aq) + Ni(s)$$

(i) List the four metals in order of decreasing reactivity. *[2]*

(ii) State and explain which is the strongest reducing agent in these reactions. *[2]*

(iii) State and explain which is the strongest oxidizing agent in these reactions. *[2]*

(b) Electrolysis of molten lead(II) bromide can be carried out using platinum electrodes.

(i) Explain why lead(II) bromide does not conduct electricity in the solid state but does in the molten state. *[2]*

(ii) State a half-equation for the reaction occurring at the positive electrode (anode) and identify whether the change is oxidation or reduction. *[2]*

(iii) State a half-equation for the reaction occurring at the negative electrode (cathode) and identify whether the change is oxidation or reduction. *[2]*

(c) The sequence shows some reactions of organic compounds.

$$\underset{\textbf{A}}{C_3H_8O} \xrightarrow{K_2Cr_2O_7/H^+} \underset{\textbf{B}}{C_3H_6O} \xrightarrow{K_2Cr_2O_7/H^+} \underset{\textbf{C}}{C_3H_6O_2}$$

(i) Describe the colour change that occurs when $K_2Cr_2O_7$ acts as an oxidizing agent. *[1]*

(ii) Deduce the names of compounds **A**, **B** and **C**. *[3]*

(iii) Compound **A** reacts with ethanoic acid to form compound **D** with molecular formula $C_5H_{10}O_2$. State the type of reaction occurring and deduce the name of compound **D**. *[2]*

(iv) Explain, with reference to the intermolecular forces present, why compound **A** has a higher boiling point than compound **B**. *[2]*